Validation of Gender and Height Predicting Femoral Size of the Oxford® Unicondylar Knee Arthroplasty: A Simplified Method

ABSTRACT

Background: Preoperative planning for implant sizes can help ensure proper implants are available as well as improve surgical efficiencies. The purpose of this study is to determine if patient gender and height can accurately predict the femoral size of the Oxford® knee.

Materials and Methods: 3986 knees (2085 female and 1901 males) that underwent a medial unicondylar knee arthroplasty (UKA) with the Oxford® mobile bearing knee (Zimmer Biomet, Warsaw, Indiana) were reviewed. Patient gender and height were compared to operative reports of the implanted femoral component. The relationship of height and femur size was then compared to create a prediction table for implant size.
Over the last 40 years, unicompartmental knee arthroplasty (UKA) has been successfully used for treatment of medial compartmental osteoarthritis of the knee. There is evidence that medial UKA may have advantages over total knee arthroplasty (TKA), including improved kinematics, range of motion, and functional outcome scores. UKA also tends to feel more “normal” than TKA. In addition, UKA has been shown to have lower infection rates, less blood loss, and lower transfusion rates compared to TKA.

There are a number of UKA knee implants, with the Oxford® mobile bearing knee (Zimmer Biomet, Warsaw, IN) being one of the most commonly used worldwide. Numerous studies have demonstrated excellent long-term success and survival with the Oxford® knee.

The Oxford® knee has gone through a series of updates over the past few decades. In the phase 1 and 2 systems, there was only one femur option. The most current design and instrumentation platform, the Oxford® Microplasty® (Zimmer Biomet, Warsaw, Indiana), offers five femoral sizes: extra-small, small, medium, large, and extra-large. In addition, femoral “spoons” were added to assist with proper femoral component sizing and tibial resection depth. This new instrumentation platform has also been shown to reduce operative time. The femoral preparation instruments are specific for each of these sizes and come in separate trays.

Arthroplasty, especially UKA, has transitioned to the outpatient space both in hospitals and ambulatory

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**INTRODUCTION**

Results: Females mean height was 64” (range, 48 to 78”) and males mean height was 70” (range, 58 to 79”). In male patients, large implants were used in the majority of cases (76.6%). In female patients, small implants were used in the majority of cases (64.3%). Based on the relationship of height and femur size, two groups were created for each gender. In males: ≤66” = medium and ≥67” = large. In females: ≤64” = small and ≥65” = medium. Using these cutoffs, the correct implant would be chosen in 78.7% of cases (82.1% in males and 75.6% in females). Extra-small and extra-large sizes were used at the extremes of height in each gender, but never more commonly than small, medium, or large at any height.

Conclusion: Patient gender and height can accurately predict femoral size of the Oxford® knee in the majority of cases. Our findings validate the original report of this method.
surgery centers (ASC). Sterilization, storing, and the opening of unnecessary instruments is a burden to the facilities and implant company representatives, and it can impede surgical efficiency with the cluttering of the operative field. As such, preoperative planning for implants is paramount to ensuring proper implants are available while limiting wasted processing.

Given that only one of the five Oxford® femoral preparation trays are needed for each surgery, it would be advantageous to know which size will be used in a particular case. Previous studies evaluating prediction of sizing of the Oxford® femoral components have shown that gender and height can more accurately predict the size than radiographic templating. However, these studies consisted of 130 patients or less. Furthermore, only one study has evaluated this predictive tool with the current Microplasty® instrumentation platform. The purpose of this study is to evaluate whether patient gender and height is a valid method of predicting femoral size with the Oxford® unicompartmental knee arthroplasty as well as offering a simplified algorithm of prediction.

**MATERIALS AND METHODS**

A retrospective review of all patients who underwent a UKA with the Oxford® knee between 2012 and 2018 was performed, yielding a cohort of 3986 knees. Patients were separated into groups by gender: 2085 females (52.3%) and 1901 males (47.7%).

All surgeries were performed with the Oxford® Microplasty® instrumentation platform. To size the femur intraoperatively with Microplasty® instruments, sizing spoons (Fig. 1) are used to determine the appropriate anterior/posterior (AP) size of the implant. The spoon is firmly hooked on the posterior femur and should sit off the anterior femur slightly to re-establish the joint line to the level prior to cartilage and bone loss. The Microplasty® instruments also have a femoral drill guide (Fig. 2) with a matching width to the final implant that can be used to estimate the appropriate medial/lateral (ML) size. Each step of the femoral preparation utilizes size-specific instruments including: sizing spoon, femoral alignment, femoral resection guide, femoral mill, feeler gauges, anti-impingement guide/mill, and femoral trials.

Patient demographics were evaluated including age, height, weight, and body mass index (BMI). Operative reports were reviewed for the femoral size that was implanted. The groups were separated by gender, and height in inches was compared to the femoral sizes used. Patients at the extremes of height were lumped into groups, which include males with a height ≤64” or ≥75” and females with a height ≤60” or ≥72”.

All patients signed a general research consent, approved and monitored by an independent institutional review board (Western IRB, Puyallup, Washington), which allows inclusion in retrospective reviews.

**RESULTS**

The mean age of the cohort was 63.8 years (range, 27 to 94 years). The mean BMI was 32.4 kg/m² (range, 17.1 to 63.8 kg/m²). The mean height in all patients was 67” (range, 48 to 79”), females had a mean height of 64” (range, 48 to 78”, SD± 1.6), and males had a mean height of 70” (range, 58 to 78”, SD± 2.5).

A summary of patient height and implants used are shown in Figure 3 for males and Figure 4 for females.

In male patients, large implants were used in the majority of cases at 76.6%. Based on height, medium implants were used in the majority of cases up to a height of 66”, at which point large
Implants became more common. Using this cutoff, medium implants were used in 75.9% of patients ≤66” and large implants were used in 82.6% of patients ≥67”. There was no height in males at which any other implant sizes were used more commonly than medium or large.

In female patients, small implants were used in a majority of cases at 64.3%. Based on height, small implants were used in the majority of cases up to a height of 64”, at which point medium implants became more common. Using this cutoff, small implants were used in 82.5% of patients ≤64” and medium implants were used in 64.1% of patients ≥65”. There was no height in females at which any other implant sizes were used more commonly than small or medium.

Using the gender/height predictions (Table I), the correct femoral size would be chosen in 78.7% of cases. It was correct in 82.1% of male cases and 75.6% of female cases.

### Table I.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Height</th>
<th>Femoral Size</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>≤66”</td>
<td>Medium</td>
<td>75.9%</td>
</tr>
<tr>
<td>Female</td>
<td>≤66”</td>
<td>Medium</td>
<td>75.9%</td>
</tr>
<tr>
<td>Female</td>
<td>≥67”</td>
<td>Large</td>
<td>82.5%</td>
</tr>
<tr>
<td>Female</td>
<td>≤64”</td>
<td>Small</td>
<td>82.5%</td>
</tr>
<tr>
<td>Female</td>
<td>≥65”</td>
<td>Medium</td>
<td>64.1%</td>
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<tr>
<td>Overall</td>
<td></td>
<td></td>
<td>78.7%</td>
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</tbody>
</table>

This study demonstrated that when using a simple method of height and gender, the appropriate femoral size with Oxford® knee can be predicted in over 78.7% of cases, validating the original report of this method.20 This does mean though that in 21.3% of cases, the size prediction was incorrect. At the extremes of height, less common sizes (i.e., extra-small and extra-large) were used. Also, as height approached the cutoff value, there was more overlap of the two common sizes in both gender groups. However, there was no height at which males had any implant more commonly used than medium or large and females small or medium. This prediction tool is best used as a guide of what femoral preparation sets to open rather than which implant to choose. Femoral spoons and alignment guides should be used to make a final size determination.

Radiographic templating is a common method for preoperative planning of implant sizes. While the authors often template for total hip arthroplasty procedures, TKA and UKA cases are rarely templated. With the Oxford® knee, femoral templating is best completed on the lateral radiograph (Fig. 5). Fawzy et al. evaluated the accuracy of radiographic femoral templating with the Oxford® knee. Radiographs of 100 patients were templated by two orthopedic surgeons and compared to implants used. They found that radiographic templating was accurate in predicting femoral size in 67% of cases.20 Tu et al. reported 59% accuracy with radiographic templating for the Oxford® knee in an Asian population.19 Others have reported even worse accuracy, 25%, with radiographic templating of femoral components in other UKA implant designs.22 Radiographic templating does take time and requires computer software or printed templates to perform. The described method of using gender and height was more accurate than these reported radiographic templating results. Furthermore, using height and gender takes very little time and can be completed by operating room staff when choosing which sets to open.

Fawzy et al. were the first to report on using gender and height as a templating tool for the Oxford® knee. They evaluated 100 knees and devised a sizing

![Figure 5. Example of radiographic templating for the Oxford® femoral component.](image-url)
algorithm with four groups per gender. With this method, they found 75% accuracy of prediction of femoral size. The current method in this study with only two groups showed similar accuracy with half of the groups. These findings help validate the previous report, while offering surgeons a simple tool to teach their surgical team. In certain populations, this method has been shown to be less accurate, with only 51.1% accuracy in a series of Chinese patients and 36.9% in Indian patients. When Tu et al. modified the gender/height algorithm for their Chinese population, the accuracy improved to 88%. Similarly, Malhotra modified the algorithm for Indian patients and improved the accuracy to 74%.

Other methods of Oxford femoral sizing have also been described. Sawalha utilized the patient’s shoe size to predict the femoral component and reported 80% accuracy. This may be a difficult tool to use as shoe size is not a common demographic that the operative team can access. Tu et al. used an intraoperative c-arm to assist in femoral sizing and reported 92% accuracy. The problem with this method is that once trialing occurs, all the femoral preparation for that specific size has been completed. The peg hole locations and radius of curvature are specific for each size and attempting to change femoral size after preparation is complete could compromise implant fit and fixation.

The sizing spoons introduced with the Microplasty instruments offer an intraoperative assessment of proper AP sizing of the femoral component. Surgeons must be careful not to overestimate size if posterior osteophytes are present and not underestimate size if there is significant distal femoral cartilage and bone loss. Malhotra et al. evaluated the accuracy of the spoons compared to postoperative radiographs to determine if an “ideal” femoral size was used. Ideal size was considered to be <2 mm of implant underhang or overhang on the posterior condyle. They concluded that spoons predicted the ideal implant size in 75% of cases. While the operative goal is to properly size the implants, component overhang with the Oxford has not been shown to affect functional outcome. There is size forgivingness with the spherical designs of this implant and previous versions, with only one femoral size demonstrating very good results. The Oxford technique guide notes that up to 4 mm of overhang is acceptable. The posterior coverage of the femoral component is not only affected by the femoral size, but also the amount of distal bone milled to balance the flexion and extension gaps. As more bone is milled, the component will sit more posterior.

While many implant designs offer a variety of sizes, it may not be necessary to have all of these implants and instruments available for every case. For example, no extra-small or small implants were ever used in males and only one extra-large implant was used in females. The authors’ ultimate decision for femoral implant size with the Oxford knee is based on intraoperative sizing using the spoons and femoral alignment jig. As noted previously, each of the femoral sizes has its own size-specific preparation tray. It would be needless and wasteful to open five trays for every surgery, when only one is used. If the surgical team did not wish to do any planning, they could open up two trays: medium and large for males and a small and medium for females, which would be correct for 96% of cases. Other sizes should be available in cases where patients are very tall or very short.

We did find a wider dispersion of implant size usage and less accuracy of the prediction model in female patients. The second most common female size, medium, was used in 1/3rd of cases, while in male patients, the next most common size, medium, was used only 18% of the time. One explanation may be that the height cutoff subgroups in each gender were not equally represented. The minority shorter male group of ≤66” represented only 7.2% of the overall male knees, while the female minority shorter group of ≥65” represented 37.7% of the female knees. Females have also been shown to have a wider variability of knee morphology, which may contribute to our findings.

Tibial sizing predictions were not evaluated in this study for a few reasons. First, the Oxford system uses a single tibial preparation tray for all sizes, and thus templating would not reduce the number of sets opened. Secondly, the size of the tibial tray is not only dependent on the AP size of the tibia, but also how far lateral the vertical cut is made. Surgeons may opt to have a slightly larger tibial component that overhangs posteriorly to ensure the component is against the vertical wall and fully covering the tibia medially.

As arthroplasty has transitioned to the outpatient space, many implant companies and facilities have made efforts to streamline instrumentation for cases. Limiting the number of instruments and trays may decrease operating room (OR) turnover time, minimize surface area for contamination, and lower facility costs. Some of these efforts include disposable custom instruments, consolidation of trays with common sizes, and using templates to predict sizes. In a template-directed instrumentation model, McLawhorn et al. were able to reduce the number of sets for a total knee from six to three, saving $74.50/case. The authors have found that rarely more than one femoral preparation tray is opened using the height/gender prediction method.

One limitation of this study is that the findings may not be applicable to all geographic regions of the world. As noted earlier, previous height and gender predictions for the Oxford knee have been shown to be inaccurate in Chinese and Indian populations. As stated previously, each of the femoral sizes has its own size-specific preparation tray. It would be needless and wasteful to open five trays for every surgery, when only one is used. If the surgical team did not wish to do any planning, they could open up two trays: medium and large for males and a small and medium for females, which would be correct for 96% of cases. Other sizes should be available in cases where patients are very tall or very short.

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One limitation of this study is that the findings may not be applicable to all geographic regions of the world. As noted earlier, previous height and gender predictions for the Oxford knee have been shown to be inaccurate in Chinese and Indian populations. Another limitation is that postoperative radiographs were not reviewed to assess whether the chosen implant size was in fact the “ideal” size for that patient based on Oxford recommendations. However, the original article describing the predictive technique of gender and height did not review postoperative radiographs either. Furthermore, the femoral sizing of the Oxford knee has never been shown to affect functional outcomes or survivorship. This logically leads to the question of why even worry about femoral size. While posterior femoral component underhang or overhang has not directly been shown to impact outcomes with the Oxford knee, there are potential problems with an improperly sized femoral component. If the femoral component is grossly undersized and posterior bone/osteophytes remain, this could increase the risk of anterior bearing dislocation. Also, not only does the AP dimension of the femoral component change with size, the implant and mobile bearing width increases as well. If too large of a femoral implant is selected, this could overhang medially, potentially causing irritation to the medial soft tissue from the femoral component and/or the moving meniscal bearing. As mentioned throughout this
article, the Oxford® knee has shown great tolerance with variation in implant position and size. However, surgeons should always strive for as anatomic of a reconstruction as possible.

CONCLUSION

In conclusion, patient height and gender can be used to accurately predict femoral implant size with the Oxford® knee. This will help ensure proper implants are available and improve operating room efficiencies. However, our specific algorithm may not be applicable to all populations.

AUTHORS’ DISCLOSURES

Institutional research funding was received from Zimmer Biomet, Inc., but no direct funding was provided for this project. Dr. Lombardi and Dr. Berend are consultants to, and receive royalties from, Zimmer Biomet, Inc. They also receive royalties from Innomed and have minority investment interests in SPR Therapeutics, Joint Development Corporation, Elute Inc., and VuMedi.

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